

# Meckel's diverticulum: a systematic review

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*J R Soc Med* 2006;99:501–505

## SUMMARY

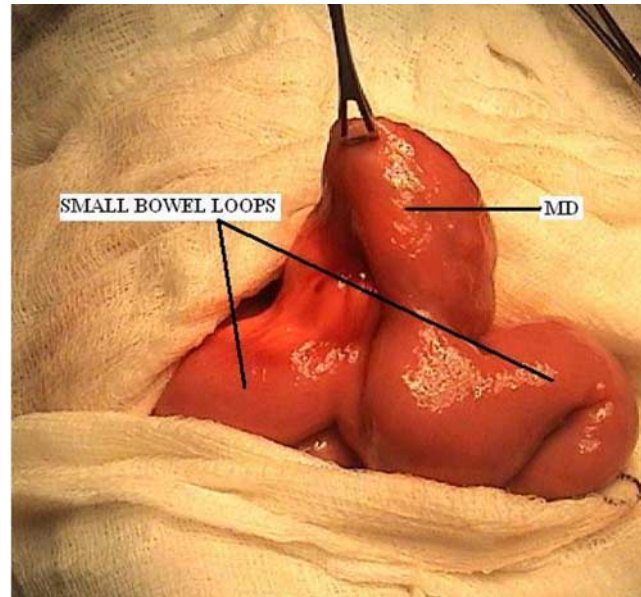
Meckel's diverticulum is the most common congenital malformation of gastrointestinal tract. It can cause complications in the form of ulceration, haemorrhage, intussusception, intestinal obstruction, perforation and, very rarely, vesicodiverticular fistulae and tumours. These complications, especially bleeding, are more common in the paediatric age group than in adults; however it is not uncommon to miss the diagnosis of Meckel's diverticulum in adults. Here, we reviewed the literature regarding the complications of this forgotten clinical entity in adults with potential diagnostic difficulties and management strategies.

## INTRODUCTION

Meckel's diverticulum is the most common congenital malformation of the gastrointestinal tract (present in 2%–4% of population) due to persistence of the congenital vitello-intestinal duct. Bleeding from Meckel's diverticulum due to ectopic gastric mucosa is the most common clinical presentation, especially in younger patients (Figure 1 in colour online), but it is rare in the adult population. The complications in adults include: obstruction; intussusception; ulceration; haemorrhage; and, rarely, vesicodiverticular fistulae and tumours. Due to the rarity of cases in adults, it is still misdiagnosed preoperatively—although with the wide spread use of technetium-99m pertechnate scan and diagnostic laparoscopic approach, the rates of preoperative diagnosis have improved. Here, we review the current literature of this forgotten clinical entity for its clinical diversity, diagnostic difficulties and management controversies.

## METHODS

We used PubMed and Medline search engines for articles containing terms such as Meckel's diverticulum, ectopic gastric mucosa, technetium-99 pertechnate scan, histopathology, treatment and complications, from 1995 to 2005. From the abstracts of those articles we selected relevant articles and reviewed them in detail. We included



**Figure 1** Intraoperative photograph of an 18-year-old male patient who presented with bleeding *per rectum*. The figure shows long Meckel's diverticulum on anti-mesenteric border of ileum with its mesentery [in colour online]

all the relevant major review articles and trials. We selected articles, which were available in full text English language. We excluded single case report unless they were of exceptional value. Additional articles were identified by a manual search of the references from the reviewed articles.

## DISCUSSION

Gastrointestinal bleeding is a major cause of emergency hospital attendance in adults. Nearly 80% of this bleeding in adults originates proximal to the ligament of Treitz. The most common source of the lower gastrointestinal bleeding is colon, with less than 5% of bleeding from small intestine.<sup>1</sup> The usual investigations include upper gastrointestinal endoscopy and colonoscopy as well as the usual biochemical and haematological investigations. Endoscopy may not be useful if there is significant blood pool obstructing the visibility. Technetium-bleeding scan and angiography may be used to diagnose rare focal sources of bleeding such as Meckel's diverticulum.

Meckel's diverticulum is the most common congenital malformation of the gastrointestinal tract—most studies suggest an incidence of between 0.6% and 4%. It is also the

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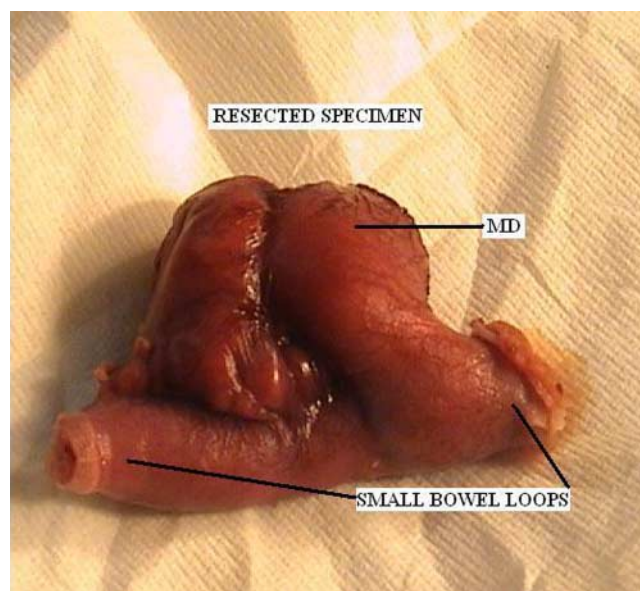


Figure 2 Resected specimen of Meckel's diverticulum with part of small bowel in the same patient [in colour online]

most common cause of bleeding in the paediatric age group. This is due to the persistence of the proximal part of the congenital vitello-intestinal duct. It is a true diverticulum, typically located on anti-mesenteric border, and contains all three coats of intestinal wall with its separate blood supply from the vitelline artery. The rare mesenteric location of Meckel's diverticulum has been documented in literature (Figure 2 in colour online).<sup>2</sup> In some surgical textbooks, it is known by the rule of two: present in 2% population, 2 ft from the ileo-caecal junction and 2 in. long, although many anatomical variations exist.

### Nomenclature and embryology

Meckel's diverticulum was first described in a paper published in 1809 by the German anatomist, Johann Friedrich Meckel, the younger (1781–1833), who described it as a remnant of the omphalo-mesenteric duct,<sup>3</sup> although such an abnormality had been mentioned quite early by Fabricius Hildanus in 1598 and in 1671 by Lavater (who did not recognize its embryological origin). However, it was not until almost 100 years later that the understanding of Meckel's diverticulum increased with the discovery of ectopic gastric mucosae by Salzer and associated ulceration of ileum by Deetz.<sup>1</sup>

In the fetal life, the omphalo-mesenteric duct connects the yolk sac to the intestinal tract and usually it obliterates in the 5th to 7th week of life. If obliteration fails, the congenital anomalies develop, leading to the residual fibrous cords, umbilical sinus, omphalo-mesenteric fistula, enterocyst and most commonly, Meckel's diverticulum.

### Clinical diversity

Meckel's diverticulum is lined mainly by the typical ileal mucosa as in the adjacent small bowel. However, ectopic gastric (most common—57% according to textbooks, but 20% according to recent data<sup>4</sup>)—duodenal, colonic, pancreatic, Brunner's glands, hepatobiliary tissue and endometrial mucosa may be found, usually near the tip.<sup>1</sup> According to J F Meckel, the incidence of the complications due to Meckel's diverticulum was 25%, but in the recent literature it ranges from 4%–16%. Its occurrence in males and females is equal, but incidence of complications is three to four times greater in males. The most frequent complications in the adults are: obstruction due to the intussusception or adhesive band (14%–53%); ulceration (<4%); diverticulitis; and perforation. In children it is the most common presentation, especially in those younger than 2 years of age (almost 50%). The large proportion of the rest of the symptomatic Meckel's diverticulum occurs in those aged 2–8 years. Bleeding from ectopic gastric mucosa, especially chronic bleeding, is not common in adults although it has been documented in a 91 year old.<sup>5</sup> Carcinoid tumour, sarcoma, stromal tumours, carcinoma, adenocarcinoma, intraductal papillary mucinous adenoma of pancreatic tissue and vesicodiverticular fistulae are also rare complications.<sup>6,7</sup> Other rare complications include inversion of Meckel's diverticulum, torsion, volvulus of ileum around Meckel's diverticulum or fibrous cord and perforation—spontaneously or by foreign body such as fish bone.<sup>8–11</sup> The risk of the complications decreases with increasing age, with no predictive factors for the development of complications. The main mechanism of bleeding is the acid secretion from ectopic mucosa, leading to ulceration of adjacent ileal mucosa. It is possible that the recurrent intussusception may cause trauma, inflammation, mucosal erosion and bleeding. The pathogenic role of *Helicobacter pylori* in the development of gastritis and bleeding in the ectopic gastric mucosa is still debatable.<sup>12,13</sup> NSAIDs' effect on the ectopic gastric mucosa is yet to be proved.<sup>14</sup> Bleeding from Meckel's diverticulum can cause the iron deficiency anaemia,<sup>15</sup> but it may also cause megaloblastic anaemia due to the bacterial overgrowth and vitamin B12 deficiency as a result of the dilatation and stasis in adjacent obstructed ileal loop. The presence of bleeding with hypoalbuminaemia and low ferritin due to ongoing slow unrecognized bleeding may lead to the diagnosis of inflammatory bowel disease. There have been reported cases of active and chronic inflammatory bowel disease in Meckel's diverticulum. The incidence is high in diagnosed cases of inflammatory bowel disease; however, the incidence of ectopic mucosa or Meckel's diverticulum mucosal involvement by inflammatory bowel disease is very low.<sup>16</sup>

In the English literature, Klinvimol *et al.* reported that out of 1489 patients only 0.27% of the patients had bleeding,<sup>16,17</sup> while Leijonmarck *et al.* recorded only 5% of patients out of 260 having bleeding.<sup>18</sup> Higaki *et al.* suggested that the mechanical stimulation was an additional cause of bleeding due to the presence of the ectopic gastric mucosa of the body type (rather than the fundic type) and submucosal fibrosis (suggesting recurrent chronic ulcerations).<sup>19</sup> Although bleeding is one of the most common presentations, its other clinical presentations may suggest various surgical diagnoses and it is imperative to differentiate Meckel's diverticulum from those surgical conditions.

### Diagnostic dilemmas

According to the well-known statement of Charles Mayo, 'MD is frequently suspected, often looked for and seldom found'. Preoperative diagnosis of symptomatic Meckel's diverticulum is difficult. This is particularly true in the patients presenting with the symptoms other than bleeding. In a study of 776 patients by Kusumoto *et al.*, 88% of patients presenting as bleeding had a correct preoperative diagnosis versus 11% with symptoms other than bleeding.<sup>19</sup> The preoperative diagnosis of Meckel's diverticulum is still an outstanding challenge—we do often come across cases that are misdiagnosed or not diagnosed preoperatively. In doubtful cases, laparoscopy is a preferred diagnostic modality.<sup>21</sup> However, technetium-99m pertechnetate scan is the most common and accurate non-invasive investigation performed for these cases (Figures 3 and 4 in colour online). Harper *et al.* introduced the scan in 1962 as a method of diagnosing Meckel's diverticulum because of tracer's propensity to concentrate in ectopic gastric mucosa (Figures 5 and 6 in colour online); but Jewett *et al.* were the first to apply it clinically.<sup>22</sup> In children, it has a sensitivity of 80%–90%, a specificity of 95% and an accuracy of 90%,<sup>23</sup> but in the adults it is less reliable with a sensitivity of 62.5%, a specificity of 9% and an accuracy of 46%.<sup>24</sup> As the technetium-99m pertechnetate scan is specific to ectopic gastric mucosa and not specifically to Meckel's diverticulum, it may be positive in gut duplication cysts with ectopic gastric mucosa.<sup>25</sup> The presentation of gut duplication cyst as bleeding *per rectum*, typical brick red rectal bleeding with pallor in infants, rather than malena or fresh bright red blood, differentiates it clinically from Meckel's diverticulum. The false negative scans may be due to the rapid dilution of radioactive secondary to fast bleeding from the ectopic mucosa, impaired vascular supply or insufficient gastric mucosa. According to the literature, the false negatives are more common in adults than children and also more common in patients presenting with other symptoms than bleeding. There may be a variety of scintigraphic patterns found in patients with ectopic gastric

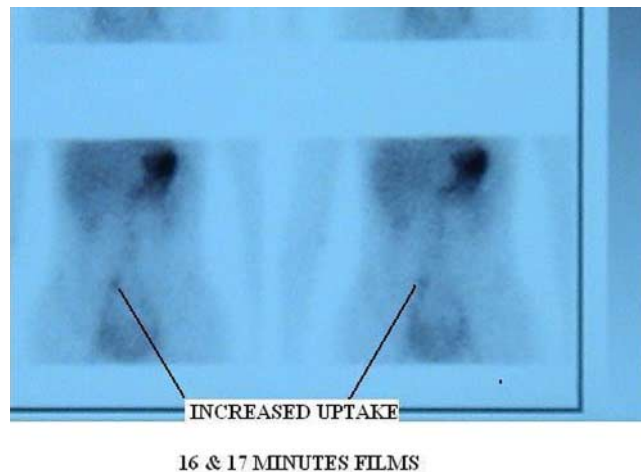


Figure 3 Technetium 99m pertechnetate scan at 16 and 17 min in the same patient [in colour online]

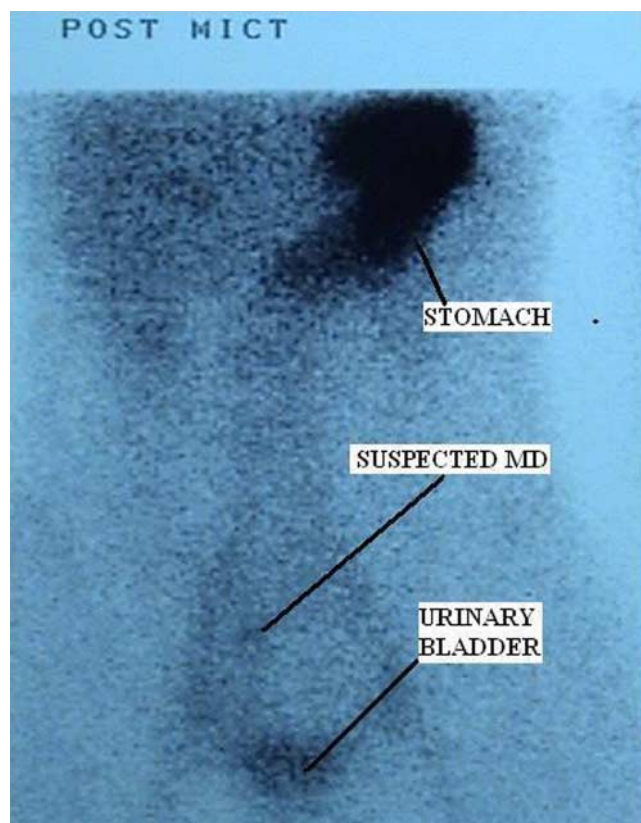


Figure 4 Technetium 99m pertechnetate scan-postmicturition film in the same patient [in colour online]

mucosa undergoing technetium-99 pertechnetate scan depending upon the location and size of ectopic tissue that needs an expert radiologist to interpret. There is some evidence in the literature that the accuracy of technetium-99m pertechnetate scan can be improved by various methods, including:

- the use of pentagastrin, somatostatin<sup>26</sup>
- H<sub>2</sub> receptor blockers<sup>27</sup>



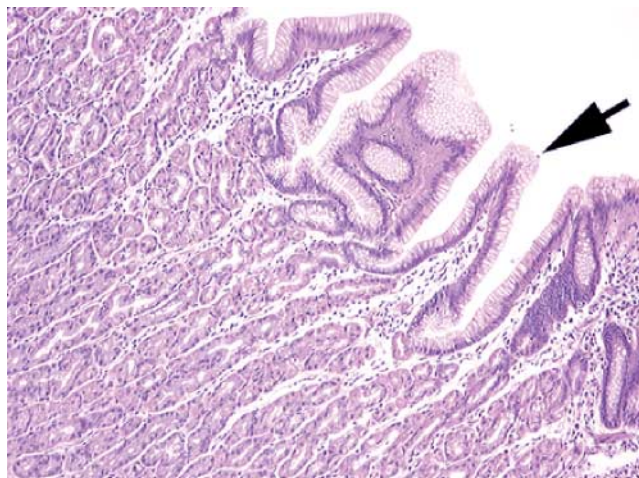


Figure 5 Heterotopic ectopic gastric fundic mucosa in Meckel's diverticulum [in colour online]

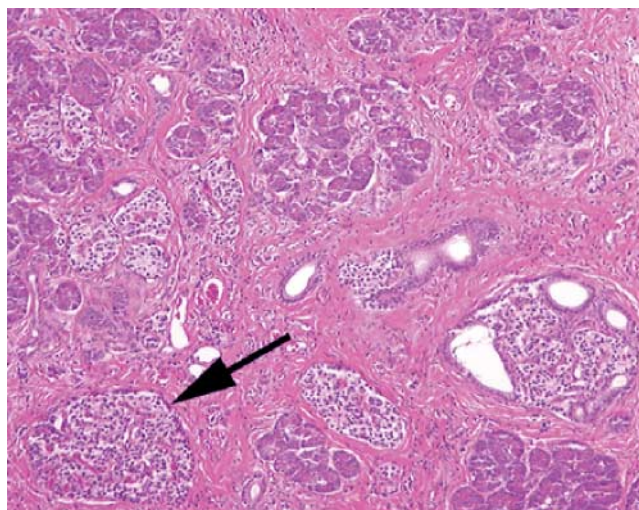


Figure 6 Heterotopic ectopic pancreatic acinar cells and islets in Meckel's diverticulum [in colour online]

- naso-gastric aspiration
- saline lavage of bladder
- and repeat scan.<sup>24,28</sup>

Other diagnostic methods have been suggested to supplement the Meckel's scan including Tc 99m RBC labelled scan, angiography and barium enema. Angiography is usually negative unless the bleeding rate is  $>0.5$  mL/min.

## Management

The treatment of choice for the symptomatic Meckel's diverticulum is the surgical resection. This can be achieved either by the diverticulectomy or by the segmental bowel resection and anastomosis, especially when there is palpable ectopic tissue at the diverticular-intestinal junction, intestinal ischaemia or perforation. There has been an

ongoing debate about the excision of Meckel's diverticulum when found as an asymptomatic incidental finding. During an operation, it is usually impossible to determine by inspection or palpation whether incidentally found Meckel's diverticulum is at increased risk of the complications or not. Mackey and Dineen have suggested statistically significant risk factors such as males less than 40 years, diverticulum longer than 2 cm and that containing ectopic mucosa.<sup>29</sup> However, Park *et al.* favoured removal of incidental asymptomatic Meckel's diverticulum in males, patients younger than 50 years, diverticulum greater than 2 cm and presence of histological abnormal tissue.<sup>30</sup> Stone *et al.* did not recommend removal of incidental asymptomatic Meckel's diverticulum in women.<sup>31</sup> Onen *et al.* recommended its removal in symptomatic as well as in asymptomatic cases in children younger than 8 years.<sup>32</sup> Ueberrueck *et al.* proposed that in cases of gangrenous or perforated appendicitis, an incidentally discovered Meckel's diverticulum should be left in place, whereas in an only mildly inflamed appendix it should be removed.<sup>33</sup> Soltero and Bill mentioned a 4.2% lifetime complication risk of Meckel's diverticulum versus 9% morbidity after incidental resection, and did not favour incidental diverticulectomy.<sup>34</sup> However, most authors do not agree with these figures; postoperative morbidity after incidental resection varies between 0% and 6%, with significant morbidity, up to 33% after resection of a complicated Meckel's diverticulum and the lifetime complication risk estimated to be up to 16%. The definitive Mayo clinic survey provides good evidence to support the role of prophylactic diverticulectomy.

## CONCLUSION

Meckel's diverticulum is the most common congenital anomaly of gastrointestinal tract. Clinical manifestations arise from complications of this true diverticulum that are most common in males under 40–50 years of age and with a diverticulum longer than 2 cm. Due to the rarity of cases in adults, especially bleeding from the Meckel's diverticulum, the misdiagnosed cases are not uncommonly reported even in developed countries. A preoperative diagnosis of a complicated Meckel's diverticulum may be challenging because of the overlapping clinical and imaging features of other acute surgical and inflammatory conditions of the abdomen. An adequate knowledge of embryological, clinical, pathologic and radiologic characteristics of Meckel's diverticulum will aid the early and accurate diagnosis of complicated cases.

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